FORMLINE
Form Metrology
Flexible and efficient form measurement

We deliver solutions that help you optimize your manufacturing process regarding qualitative and economic objectives.

We, the Industrial Metrology Division of the Jenoptik Group, are one of the leading international specialists in high-precision, tactile and non-tactile production metrology.

Our services range from complete solutions for different measuring tasks such as the inspection of surface and form as well as determining dimensions, throughout every phase of the production process including final inspection or in the metrology lab.

Our decades of experience in tactile, optical and pneumatic measurement combined with our global sales and service support network brings us close to you, our customers, enabling us to provide optimal support as a reliable partner.

Our team is looking forward to your inquiry!

Jenoptik – Sharing Excellence
Measuring solutions for your applications

Measuring systems of our FORMLINE series offer you extensive evaluation possibilities for rotation symmetric and cubic workpieces (depending on the system):

**Form tolerances**
- Straightness
- Roundness
- Flatness
- Cylindricity

**Run-out tolerances**
- Radial run-out
- Axial run-out
- Total radial run-out
- Total axial run-out

**Position tolerances**
- Parallelism
- Perpendicularity
- Angularity
- Coaxiality, concentricity

**Specific parameters**
- Diameter
- Conicity
- Position deviation
- Length
- Stroke radius
- Crowning
- Angle deviation
- Waviness analysis
- Twist
Get better measurements

… with versatility
The modular design of our FORMLINE solutions guarantees maximum flexibility for a wide range of applications. Our product line includes compact roundness measuring devices, standard and custom CNC measuring systems for the determination of all form and positional tolerances as well as combined form and surface roughness measuring systems. You also get solutions for large, heavy and cubic workpieces or specific crank shaft and cam shaft measurements or form measurement in cylinder bores.

… in day-to-day operations
FORMLINE solutions measure with high accuracy in the measuring lab or in the shop floor. With a user-friendly evaluation software, they are easy to use and can be easily adapted to numerous measuring tasks thanks to an extensive range of accessories.

… with speed
Time is money. That’s why we focus on automated measuring runs and FORMLINE solutions, that offer optimized processes, adapted to the measuring tasks.

… with professional metrology
FORMLINE solutions are the result of our decades of experience and extensive know-how in form metrology. They boast explicit measurements according to standards, easy operation and professional evaluation of the measured values.

… with customized solutions
For your specific requirements, we develop measuring systems, that are adapted to your needs. You can rely on our experience in the development of customized solutions, for example for break discs, pistons, valves, conrods or injection parts.
<table>
<thead>
<tr>
<th>Model</th>
<th>Brief description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>F50, F135, F155</td>
<td>Compact and ergonomic form measuring systems</td>
<td>6–7</td>
</tr>
<tr>
<td>F435, F455</td>
<td>Fully automatic measurement of all form and positional tolerances, roughness and twist measurement as an option</td>
<td>8–9</td>
</tr>
<tr>
<td>roundscan</td>
<td>Combined form and roughness measuring systems with optional twist measurement</td>
<td>10–11</td>
</tr>
<tr>
<td>FMS8200</td>
<td>Spindle measuring machines for heavy workpieces with a large measuring volume</td>
<td>12–13</td>
</tr>
<tr>
<td>TURBO FORM</td>
<td>Evaluation software for F series, roundscan and FMS</td>
<td>14–18</td>
</tr>
<tr>
<td>CFM, shaftscan, CCM</td>
<td>Measuring machines for crank shafts and cam shafts</td>
<td>25–27</td>
</tr>
<tr>
<td>TURBO SHAFT</td>
<td>Evaluation software for CFM, shaftscan and CCM</td>
<td>30–31</td>
</tr>
<tr>
<td>incometer</td>
<td>Measuring systems for form and roundness in cylinder bores</td>
<td>32–35</td>
</tr>
<tr>
<td>INCOWIN</td>
<td>Evaluation software for incometer</td>
<td>36–39</td>
</tr>
</tbody>
</table>
Accurate and cost-efficient roundness measurements

With the compact F50 form measuring system you perform roundness measurements quickly and accurately.

**System features**
- Highly accurate air bearing rotary table with a diameter of 150 mm
- Menu-guided manual centering and leveling
- Measuring probe with adjustable measurement force and large measuring range
- Continuously adjustable measurement speed
- Manual Z and R axes
- Simplified software user interface with all the key functions in one view
- Optional tilt arm FS1 for variable probing positions

**Your benefits**
- Universal roundness measuring system with extensive evaluation possibilities
- Professional print reports for documentation of your production quality
- Secure and simple operation via the Windows-based evaluation software
- Fast and efficient measurements
- High-quality, maintenance-free air bearing for maximum precision at all times
- Compact and robust desktop device, which is ideal for flexible use during production

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>ø workpiece</th>
<th>ø measurable</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
<th>Measuring axes</th>
<th>Option roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>F50</td>
<td>25 kg</td>
<td>220 mm</td>
<td>300 mm</td>
<td>320 (560 mm)</td>
<td>manual</td>
<td>C</td>
<td>no</td>
</tr>
</tbody>
</table>

1) Probe in upward position
Form measurement of precision parts made easy

The F135 and F155 measurement systems are the best choice for measuring the roundness and cylindricity of your precision parts.

**System features**
- Highly accurate air bearing rotary table with a diameter of 150 mm
- Menu-guided manual centering and leveling
- Measuring Z and R axes for cylinder form and straightness measurements
- Probe protected against collisions
- Allows probe movement past the center of the table to measure parallelism and conicity without rotating the table
- Tilt arm FS1 for variable probing positions, even on complex workpieces
- Automatic workpiece alignment

**Your benefits**
- Universal system for cylinder form measurements with extensive evaluation functions
- Automated measurement runs
- Professional print reports for documentation of your production quality
- Two models to choose from, depending on the workpiece length
- Extensive range of probes for numerous measuring applications
- Capable assistant for easy creation of test plans

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>ø workpiece</th>
<th>ø measurable</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
<th>Measuring axes</th>
<th>Option roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>F135</td>
<td>25 kg</td>
<td>300 mm</td>
<td>320 mm</td>
<td>350 mm</td>
<td>manual</td>
<td>C, Z, R</td>
<td>no</td>
</tr>
<tr>
<td>F155</td>
<td>25 kg</td>
<td>300 mm</td>
<td>320 mm</td>
<td>550 mm</td>
<td>manual</td>
<td>C, Z, R</td>
<td>no</td>
</tr>
</tbody>
</table>
Fully automatic measuring of all form and positional tolerances

The F435 and F455 form measurement systems allow you to determine all form and positional tolerances in a precise and reliable manner.

**System features**

- Highly accurate air bearing rotary table (250 mm) with automatic centering and leveling of the workpiece
- Three motorized measuring axes
- Vertical measuring axis with a measurement range of either 350 mm or 550 mm
- New generation of probes with magnetic coupling for fast probe arm changes
- Tilt arm FS1 for perfect probe positioning, even on complex workpieces
- Available as a desktop device or as an ergonomic measuring station
- Optional instrument table with air damping or spring elements

**Your benefits**

- Precise measurement of roundness, cylinder form and flatness
- High degree of automation thanks to automatic centering and leveling of the workpiece and CNC controlled measuring axes
- Easy CNC programming and workpiece-specific measurement documentation
- Capable evaluation software for determination of all form and positional tolerances
- For demanding measuring tasks in series production or for frequently changing tasks in the metrology lab
- Optional roughness and waviness measurement with free probing system in Z-direction
- Optional twist measurement according to MBN 31007-07 V02

---

**Model Workpiece weight Ø workpiece Ø measurable Measuring height Centering/leveling Measuring axes Option roughness**

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>Ø workpiece</th>
<th>Ø measurable</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
<th>Measuring axes</th>
<th>Option roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>F435</td>
<td>40 kg</td>
<td>400 mm</td>
<td>430 mm</td>
<td>350 mm</td>
<td>automatic</td>
<td>C, Z, R</td>
<td>yes, Z axis</td>
</tr>
<tr>
<td>F455</td>
<td>40 kg</td>
<td>400 mm</td>
<td>430 mm</td>
<td>550 mm</td>
<td>automatic</td>
<td>C, Z, R</td>
<td>yes, Z axis</td>
</tr>
</tbody>
</table>

---

*HOMMEL-ETAMIC F435, ergonomic measuring station*
Optional roughness and waviness measurement
Thanks to the new FT1.1 probe generation and a both-sided probing system, roughness and waviness measurements can be performed in addition to form measurements. And all this in a single clamping operation, saving you both time and money.

Fully automatic measurements
Thank to the optional MDS motorized tilt and rotation module, fully automatic axial and radial measurements can be performed without interrupting the CNC run.
• The module has one motorized axis for tilting (90°) and one for rotating (270°) the probe, allowing it to reach measurement positions that are hard to access
• Autostop function with intelligent, computer-aided approach with automatic detection of the probing direction

Compact desktop device
Depending on requirements, the F435 and F455 measurement systems are available either as a compact desktop device or integrated into an ergonomic measuring station.
Highly efficient solution for combined form and roughness measurements

Depending on the measurement task, the combined form and roughness measurement systems from the roundscan series can be configured to create the measurement situation that best suits your requirements.

**System features**

- Highly accurate air bearing rotary table with impressive rigidity for consistently high precision
- Vertical measuring axis available in three different heights, depending on requirements
- Optional air spring damping system with active level control and customized enclosure for production-adapted use
- Basic version for form measurement with 1 µm resolution of the R/Z axis and 20,000 points in the C axis
- High Resolution version (HR) for combined form and roughness measurements with 0.1 µm resolution in the R/Z axis and 360,000 points in the C axis, as well as integrated linear scale and active level control

**Your benefits**

- Very fast, fully automatic centering and leveling system for time savings of up to 60 % compared with conventional measuring devices
- Small parts such as valves can be measured with a small measuring circle
- Three very fast, fully CNC controlled measuring axes ensure safe, automatic measuring, even on complex workpieces
- Ergonomic measuring station for convenient operation
- Combined form, roughness and twist measurements in a single clamping operation with no probe arm changes

Depending on the measurement task, the combined form and roughness measurement systems from the roundscan series can be configured to create the measurement situation that best suits your requirements.
Fully automatic measurements with innovative probe system for efficient measurement of form, roughness and twist

- CNC controlled tilt and rotation module MDS3 for measurements at any position on the workpiece
- Probing system for measurements with two different probe tips for form and roughness
- Adjustable and switchable probe force for measurements in accordance with standards
- Probing system can be switched from form to roughness during the CNC run
- High resolution of the axes for a minimal measuring point distance for roughness measurements
- Low measurement speed from 0.2 mm/s can be run
- Only very low basic interference of the measuring axes, even at maximum resolution
- Form and roughness measurements can be programmed fully automatically; no retooling times for fast and reproducible measurements
- Fast probe arm changes and protection against collision thanks to magnetic coupling

Ergonomic measuring station

- Height-adjustable, tiltable evaluation unit
- Convenient standing and sitting workstation
- Lockable cabinets for safe storage of evaluation computer and printer
- Control panel for performing key operations while maintaining a view of the measurement task
- Integrated probe arm rest

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>Ø workpiece</th>
<th>Ø measurable</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
<th>Measuring axes</th>
<th>Option roughness (HR models)</th>
</tr>
</thead>
<tbody>
<tr>
<td>roundscan 535</td>
<td>60 kg</td>
<td>740 mm</td>
<td>390 mm</td>
<td>350 mm</td>
<td>automatic</td>
<td>C, Z, R, X, Y</td>
<td>yes, C, Z, R axes</td>
</tr>
<tr>
<td>roundscan 555</td>
<td>60 kg</td>
<td>740 mm</td>
<td>390 mm</td>
<td>550 mm</td>
<td>automatic</td>
<td>C, Z, R, X, Y</td>
<td>yes, C, Z, R axes</td>
</tr>
<tr>
<td>roundscan 590</td>
<td>60 kg</td>
<td>740 mm</td>
<td>390 mm</td>
<td>900 mm</td>
<td>automatic</td>
<td>C, Z, R, X, Y</td>
<td>yes, C, Z, R axes</td>
</tr>
</tbody>
</table>

MDS3 with both-sided probing system
FT3 with collision protection

Height-adjustable evaluation unit

Model Workpiece weight Ø workpiece Ø measurable Measuring height Centering/leveling Measuring axes Option roughness (HR models)
roundscan 535 60 kg 740 mm 390 mm 350 mm automatic C, Z, R, X, Y yes, C, Z, R axes
roundscan 555 60 kg 740 mm 390 mm 550 mm automatic C, Z, R, X, Y yes, C, Z, R axes
roundscan 590 60 kg 740 mm 390 mm 900 mm automatic C, Z, R, X, Y yes, C, Z, R axes
Spindle measuring machines for large and heavy workpieces

The specific machine design of the FMS8200 spindle measuring machine with a rotating probing system and five measuring axes offers you a flexible solution for the automated measurement of all form and positional tolerances on large and heavy workpieces.

System features
- Rotating probing system with automatic weight balance
- Automatically movable air bearing X-Y table with large support area
- In X-Y table integrated axes (A, B) for automatic workpiece alignment
- X, Y and Z axes with straightness measuring function
- Five measuring axes, two alignment axes as well as optional movement axis for the measurement of V motor blocks
- Automatic setting of the probing system to the workpiece diameter

Your benefits
- Fully automated measuring runs with extensive evaluation possibilities
- Especially suited for cylinder heads, motor blocks, large liners, gear boxes, crank shafts, large-bore pistons, etc.
- Freely movable operator terminal for the entire machine control
- Comprehensive collision protection for a long service life and increased productivity
- Automatic changeover of the probing direction for different measurements in a single clamping operation
- Easy changing of the workpiece thanks to large measuring and travel ranges of the axes
Crank shaft measurement
The crank shaft measurement arm is used for axial and radial measurements on main bearings and pin bearings with no probe changes. The measurement arm is available with either an automatically or manually rotating probe.

Tilt module
The tilt module enables automatic positioning of cylinder heads or motor blocks. Valve seats and cylinder bores of V motor blocks can be completely CNC measured.

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>X-axe</th>
<th>Y-axe</th>
<th>Measuring height</th>
<th>Workpiece alignment</th>
<th>Measuring axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMS8200</td>
<td>300 kg</td>
<td>800 mm</td>
<td>300 mm</td>
<td>1300 mm</td>
<td>automatic</td>
<td>C, Z, R, X, Y</td>
</tr>
</tbody>
</table>
Software with clear user guidance for reliable measurement evaluation

The graphical, function-oriented TURBO FORM user interface ensures simple operation, even when performing complex measurement tasks:
- User-friendly interface with clear icons
- Simple definition of measurement positions and axis references
- Direct transfer of positions via teach-in
- Simple CNC programming using pictograms
- Fully automatic alignment and measurement of workpieces
- Comprehensive profile analysis and complete documentation of the measurement results

Performance features
- Clear program flow
- Evaluation in accordance with standards
- Convenient test plan management
- User-defined presentation of measuring reports
- Numerous options for special applications
- Fast evaluation algorithms for prompt results
- CNC modules, Fourier analysis and 3D analyses included in the standard scope of delivery
- PDF output for storage of forms (CNC or manual)

Creating test plans
By clicking the mouse you select the required characteristic. The wizard guides you simply and safely through all the necessary steps.

Automatic alignment
Alignment is semi-automatic or fully automatic (depending on the device version) and is supported by the software to optimum effect.
**Automatic measurement runs: CNC**
A CNC run is quicker than a manual measurement sequence and provides user-independent, reproducible results. CNC programs are created by single steps in the teach-in mode and can then be changed step by step, either as a total measurement run or in single steps.

**Fourier analysis**
The measured profile is deconstructed into its spectral components and displayed as a graphic. Tolerance limits are defined with a limiting curve and a warning limit in order to detect recurring, high-frequency profile parts, such as chattermarks.

**Measuring**
Depending on the device type, measuring is performed manually or fully automatically via a CNC measuring program. The aligned workpiece is (automatically) measured at the measuring positions defined in the test plan. The measuring profile can be viewed, allowing an evaluation to be performed while the measuring process is still underway.

**Analysis and documentation**
After scanning the workpiece, the measuring profiles are displayed clearly and in accordance with standards in (3D) diagrams. Printing and saving of the reports can be integrated directly into the automatic run. Measurement data can also be exported via an optional interface.
Software options for the evaluation of special measuring tasks

**Line form**
Evaluation of the line form by a nominal curve with even tolerance band.

**Angular sector**
Determination of the greatest roundness error within a defined angle segment.

**Fourier synthesis**
Extraction of individual frequency ranges. Characteristics, which are then formed, no longer contain these waves.

**Cone**
Calculation of the cone angle from two polar or two linear profiles. Determination and clear 3D display of conical form and run.

**qs-STAT® interface**
Certified according to AQDEF. Transfer of the measuring data to the statistics package qs-STAT® for process data analysis.

**ASCII export interface**
Export of calculated characteristics and their measured values in ASCII format for further processing in other software programs such as Excel.

**Piston measurement**
Evaluation of non-standardized characteristic types on pistons, e.g. evaluation of the ovality, reference bolt axis or linear form.

**Brake disc measurement**
Evaluation of certain important properties of brake discs such as wobble, thickness difference, waviness and wear measurement.
Evaluation of roughness, waviness and profile

This optional module for the F435 and F455 models, as well as the High Resolution (HR) versions of the roundscan, enable fast, simple calculation, evaluation and graphical representation of all standard roughness, profile and waviness parameters in accordance with DIN/EN/ISO/JIS standards.

Performance features
• Various standard forms for evaluation
• Simple, clear configuration of measurement conditions
• Individual combination of parameters depending on the measurement task
• A wide range of display options simplifies profile analysis, e.g. superposition of several profiles, zoom, filter or fault extraction
• Free and individual design of screen and print forms
• Clear display of all form and roughness parameters in a characteristics table
• The key information is visible at a glance via the tolerance output and the status display

Automatic roughness evaluation (CNC)
Roughness measurement positions are integrated into the CNC run by the appropriate program button. Measurement conditions such as probing force are adapted automatically. The results are displayed directly in the automatic measurement run and printed as required. They can also be saved as a PDF file or exported via the ASCII or qs-STAT® interface (optional).
Twist refers to periodic structures which are comparable with the course of a thread. Magnified many times, it is visible as a micro-grinding structure. Twist structures at the sealing surfaces of shafts occur during grinding and impair the sealing function between the shaft and the sealing ring.

The most important properties of these structures can be determined with a 3D evaluation of the surface. The contact zone of the shaft is measured as a 3D area with a roughness stylus tip over a series of envelope line profiles. This allows a graphic representation of the twist structure as well as calculation of the twist parameters.

**Twist parameters**
The F435, F455 and roundscan systems support the current version of the Daimler standard MBN 31007-7 from 2009. This means that all parameters such as Number of threads DG, Twist depth Dt [µm], Period length DP [mm], Feed cross section DF [µm²], Feed cross section per revolution DFu [µm²/r], Contact length in percent DLu [%] and Twist angle Dγ [°] can be determined. Due to the optimized evaluation algorithms, the measurement results are much more stable. The reduction of the standard evaluation length from 5 mm to 2 mm reduces time considerably.

**TwistLive® analysis method**
With this modern analysis method for all roundscan systems, the normal measurement time may be reduced by 75 %. During the measuring progress, a results forecast of the twist parameters is already possible – live!
We offer a wide range of standard and custom accessories for handling even the most complex workpieces.

**Chucks**

With three, six or eight hardened clamping jaws for secure clamping of the workpieces on the rotary table.

**Chuck FX70**
- Chuck range
- Internal 18–62 mm
- External 2–68 mm
- Art. 232 036

**Chuck FX100**
- Chuck range
- Internal 28–95 mm
- External 2–95 mm
- Art. 232 357

**Chuck FX150**
- For 250 mm rotary table
- Chuck range
- Internal 46–140 mm
- External 2–140 mm
- Art. 232 359

**Motorized tilt and rotation module**

**for F435 and F455**

With this module the probe is always positioned in the optimum probing position on the workpiece. Thus complex workpiece geometries can also be measured fully automatically.

Art. 1006 0796

**Instrument tables**

For F series desktop devices

- GTS with drawers  
  Art. 232 900
- GTS-K  
  Art. 232 901
- For F435 and F455
  - GTF-3 with steel spring damping elements  
    Art. 1006 3184
  - GTF-3 with air spring damping system with active level control  
    Art. 1006 3185
Probe arms – basis for high-precision measurement

Probe arm set FTS1 for F50, F135 and F155
To cover the most common measurement tasks. Art. 230 580

The components of the probe arm set may also be ordered separately:

**Extension L030**
- L = 30 mm (2x); M2 thread 
  Art. 051 210
- Probe tip M2 KU500/R L20
  L = 20 mm; 1 mm ruby ball;
  M2 thread 
  Art. 051 209
- Probe tip FO KE300/90H L10 D2/10
  L = 10 mm; 2 conical tips 
  Art. 519 520
- Probe tip FO KU1500/R L20 D2/18.5
  L = 18.5 mm;
  3 mm ruby ball 
  Art. 243 877
- Probe tip FO KE300/90H L35 D2/35
  L = 35 mm; 2 conical tips 
  Art. 241 712
- Probe tip FO TO250-8000/60H L40 D2/40
  L = 40 mm; axe probe tip with
  0.25 mm and 8 mm radius 
  Art. 243 681
- Key for changing the probe tip M2 
  Art. 051 215

**Probe arm FT-R-L100-KU 1.5**
- L = 100 mm, 3 mm probe ball 
  Art. 230 615

**Probe arm FT-HR-L040/L100-D2**
- 2 mm bore for inserting probe tips
  L = 40 mm 
  Art. 230 630
  L = 100 mm 
  Art. 230 634

**Probe arm FT-HA-L020-M2**
- M2 thread for screwing on probe tips
  L = 20 mm 
  Art. 230 561
Carbon fiber probe arms for F50, F135 and F155
State of the art carbon fiber probe arms deliver excellent stability and maximize measurement flexibility. Available in standard and custom sizes, which can be quickly and easily adapted to a variety of measurement situations. Below are examples of different types of probe arms.

**Probe arm FT-HR-L040/L100-M2**
- 2 mm thread for screwing on probe tips
- L = 40 mm  Art. 244 940
- L = 100 mm  Art. 244 941
- Probe tip with 3 mm ruby ball
  Art. 063 935

**Probe arm FT-HR-L404/L100-D2**
- for inserting 2 mm probe tips
- L = 40 mm  Art. 256 720
- L = 100 mm  Art. 1000 1880
- Probe tip with 2 conical tips  Art. 243 938
- For measurements on ground and slightly soiled measurement positions

**Probe arm FT-R-L097,75-KU0,15**
- with tip contacting at an angle
  Art. 241 561
- For measurements on envelope lines

**Probe arm FT-AR-L040/072,25**
- Special version
- With cross pin  Art. 256 729
- For measurements on end surfaces, in bores above 3 mm and on the bottom surfaces of bores

**Probe arm FT-A-L040-KE5**
- L = 40 mm, diamond Tipp with 90°, 5 µm
  Art. 513 140
- For twist measurement
Probe arms for individual measuring tasks

**Probe arm set FTS3 for F435, F455 and roundscan**
To cover the most frequent measurement tasks.
Art. 1002 9224

The parts of the probe arm set can also be ordered individually.

- **Probe tip FO KE300/90H L10 D2/10**
  L = 10 mm; 2 cone tips  
  Art. 519 520

- **Probe tip FO KE300/90H L35 D2/35**
  L = 35 mm; 2 cone tips  
  Art. 241 712

- **Probe tip FO KE300/90H L10,4 D4-2**
  L = 10.4 mm; cone tips  
  Art. 243 519

- **Pin wrench M2**
  Art. 051 215

- **Extension L060**
  L = 60 mm; M2 thread  
  Art. 1003 4259

- **Probe tip M2 KU1000/R L20**
  L = 20 mm; 2 mm ruby ball;  
  M2 thread  
  Art. 051 207

- **Probe arm FTM-HR-L038*098 - D2*D2**
  Two 2 mm bores for inserting stylus tips. The probe tip at 38 mm is suitable for the outside measurement; the probe tip at 98 mm is used for measurements in bores.  
  L = 38 mm + 98 mm  
  Art. 1003 0456

- **Probe arm FTM-HA-L018-M2**
  M2 thread for screwing on probe tips.  
  L = 18 mm  
  Art. 1000 3942

- **Standard probe arm with probe tip**
  Delivered with every device.

- **Probe arm FTM-HR-L038-D2**
  L = 38 mm  
  Art. 1000 3955

- **Probe arm FO KU1500/R L20 D2**
  L = 20 mm; 3 mm ruby ball  
  Art. 243 877
### Probe arms with M2 thread and matching probe tips for F435, F455 and roundscan

**Probe arm FTM-HR-Lxxx-M2**
- Lateral M2 thread for screwing on probe tips.
- **L** = 38 mm  
  - Art. 1000 3938
- **L** = 98 mm  
  - Art. 1000 9711
- **L** = 158 mm  
  - Art. 1000 9714
- **L** = 200 mm  
  - Art. 1003 8257

**Probe arm FTM-HR-L038*098 – M2*M2**
- Two lateral M2 threads for screwing on probe tips.
- **L** = 98 mm + 38 mm  
  - Art. 1002 4596

### Probe tips M2 with ruby ball
- Standard stylus tips for precise form measurement.
- **Probe tip M2 KU1000/L10,0 D1,0**
  - L = 10 mm; 2 mm ruby ball;  
  - Art. 051 208
- **Probe tip M2 KU1000/L15,0 D1,0**
  - L = 15 mm; 2 mm ruby ball;  
  - Art. 1002 9794
- **Probe tip M2 KU1000/L20,0 D1,0**
  - L = 20 mm; 2 mm ruby ball;  
  - Art. 051 207

### Probe tips M2 with diamond tip
- For the exact determination of the surface parameters.
- **Probe tip M2 KE5 / 90GD L05,0**
  - L = 5 mm; diamond tip 90° / 5 µm;  
  - Art. 1002 9793
- **Probe tip M2 KE5 / 90GD L15,0**
  - L = 15 mm; diamond tip 90° / 5 µm;  
  - Art. 1002 5091

### Probe tips M2 with cone
- For measurements on ground and lightly soiled measuring points.
- **Probe tip M2 KE300/90H L5,0**
  - L = 5 mm; cone tip 90° / R 0,3 mm;  
  - Art. 1004 4157
- **Probe tip M2 KE300/90H L10,0**
  - L = 10 mm; cone tip 90° / R 0,3 mm;  
  - Art. 1004 4188
- **Probe tip M2 KE300/90H L15,0**
  - L = 15 mm; cone tip 90° / R 0,3 mm;  
  - Art. 1004 4189

### Special probe arms for measurements in small bores from 3 mm

**Probe arm FTM-R-L099-KE0,3-60H**
- For form measurement.
- **L** = 99 mm; cone tip 60° / R 0,3 mm;  
  - Art. 1001 1703

**Probe arm FTM-R-L098-KE0,005/ 60D**
- For roughness measurement.
- **L** = 98 mm; diamond tip 60° / 5 µm; 45° mounting;  
  - Art. 1004 0375
- **L** = 98 mm; diamond tip 60° / 5 µm; 45° mounting;  
  - Art. 1004 0389
Permanent measurement accuracy

DAkkS-DKD calibration laboratory
Continuous monitoring of optimum measurement accuracy is necessary to ensure perfect functioning of the measuring instruments. This is because changes in function can occur over the course of normal use, especially due to wear and tear, and these types of changes can go unnoticed. We calibrate the standards you send us in our ISO/IEC 17025 accredited DAkkS-DKD calibration laboratory. This ensures direct tracing of the gaging components to the Federal Physical-Technical Institute (PTB) and guarantees measurements and calibrations at the highest technical standard for measuring.

If a standard cannot be calibrated, a new one can be obtained directly from any of our manufacturing facilities. Simple factory calibration certificates and test reports for non-accredited parameters are also available. We also carry out capability tests for demanding measurement tasks.

Our range of calibration services:
Our DAkkS-DKD accreditation includes the measurement of variables such as roughness, profile depth, roundness, straightness, and parallelism as well as contour standards and roughness measurement instruments. Within this scope we offer:
- DAkkS-DKD calibration certificates for form standards
- DAkkS-DKD calibration certificates for contour standards
- DAkkS-DKD calibration certificates for roughness standards
- DAkkS-DKD calibration certificates for roughness measurement systems

DAkkS-DKD calibration certificate for form standards
Calibration is carried out on our DAkkS-DKD measuring station in an air-conditioned, vibration-insulated measuring room. All common form characteristic values can be determined.

Magnification standard FN101
For inspecting the amplification of the probing system.
With test report  Art. 521 809
With DAkkS-DKD calibration certificate  Art. 532 528

Roundness standard FN111
Made of ceramic. For inspecting the radial roundness deviation of the rotational axis.
With test report  Art. 521 799
With DAkkS-DKD calibration certificate  Art. 532 529

Roughness standard RNDX2 with standard holder FNR
Geometry standard RNDX2 made of nickel with an extra hard protective coating and triangular/sinusoidal grooves. For inspecting the roughness measurement of the Z and R axis.
Delivered with test report and standard holder FNR for one or two geometry standards of the RNDH or RNDX type.
Ra: approx. 1.0 µm;
Rz: approx. 3.3 µm
Art. 1003 4205

Set of twist standards
With 10 and 30-turn left twist. For inspecting the accuracy of the measuring systems.
Delivered with test report.
Art. 1001 6265
Comprehensive competence for crankshafts, gear shafts and cam shafts

Measure your crankshafts and camshafts quickly and accurately with the fully automatic, CNC controlled CFM3010 measuring machine.

System features
• Gaging component capability: measuring accuracy with repeatability of up to 0.3 µm
• Distance between tips: 1250 or 1500 mm
• Fast measurement value recording
• Choice of manual or automatic loading
• Wear-free air bearing measuring slides
• Capable evaluation software TURBO SHAFT for camshafts and crankshafts

Your benefits
• Secure measurement results, as there are no mechanical transverse forces
• Excellent basic accuracy thanks to high-resolution measurement systems
• Robust construction with vibration decoupling for use in the measuring room or in the laboratory
• Optimized CNC runs in conjunction with high measurement and travel speeds
• Can be used flexibly for a variety of workpieces

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>Test diameter</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFM3010</td>
<td>150 kg</td>
<td>300 mm</td>
<td>1250 or 1500 mm</td>
<td>automatic</td>
</tr>
</tbody>
</table>
High-End solution for crank shaft and cam shaft measurements

Thanks to its sophisticated and intelligent hardware and software components, the shaftscan 1030 offers highly accurate top-of-the-range crank shaft and cam shaft measurements.

System features
• Robust construction, as well as dual vibration decoupling, for use in the measuring room and in production
• Optimized machine concept with ergonomic design, height-adjustable evaluation unit and easy loading
• Evaluation of form and positioning, lengths and diameters, and all cam form deviations and chattermarks
• Pneumatic lifting of the tailstock with position indicator and automatic clamping for distinct clamping position
• Integrated storage compartment for gaging components and accessories
• Wear-free air bearing measuring slides
• Capable evaluation software TURBO SHAFT for cam shafts and crank shafts

Your benefits
• Fast, simple program setup
• Excellent cost-efficiency and service life thanks to fast measurement and travel speeds and the use of wear-free components
• Maximum accuracy with flexible use for different shafts
• Short travel distances and measuring times thanks to arbitrary order of repeat measurements of selected measuring points
• Two measuring heads as an option for reduction of cycle times

Thanks to its sophisticated and intelligent hardware and software components, the shaftscan 1030 offers highly accurate top-of-the-range crank shaft and cam shaft measurements.

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>Test diameter</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
</tr>
</thead>
<tbody>
<tr>
<td>shaftscan 1030</td>
<td>150 kg</td>
<td>300 mm</td>
<td>1000 mm</td>
<td>automatic</td>
</tr>
</tbody>
</table>
Specialist for cam shaft and cam form deviation measurements

Maximum mechanical accuracy and production-oriented robustness coupled with proven evaluation software are just some of the outstanding features of this CNC controlled cam shaft measuring machines.

**System features**
- Continuous zero-point inspection of the measurement systems for optimum intrinsic machine safety
- Robust construction and dual vibration decoupling for use in the metrology lab or in production
- High-resolution measurement systems for excellent basic accuracy
- Wear-free thanks to pneumatic tailstock lifting for positioning

**Your benefits**
- Horizontal structure for optimum handling of workpieces
- Measurement of all cam form deviations using suitable cam fitting processes
- Two measuring heads used in parallel ensure fast measurement runs
- Optimized CNC runs in conjunction with high measurement and travel speeds
- PTB certified evaluation algorithms

<table>
<thead>
<tr>
<th>Model</th>
<th>Workpiece weight</th>
<th>Test diameter</th>
<th>Measuring height</th>
<th>Centering/leveling</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCM2010</td>
<td>50 kg</td>
<td>120 mm</td>
<td>1100 mm</td>
<td>automatic</td>
</tr>
<tr>
<td>CCM2020</td>
<td>50 kg</td>
<td>120 mm</td>
<td>1000 mm</td>
<td>automatic</td>
</tr>
</tbody>
</table>
Accessories for CFM, shaftscan and CCM

We offer a wide range of standard and custom accessories for easy handling of the workpiece. Our decades of experience in the field of crank shaft and cam shaft measurement ensure that you get the perfect solution even for complex measurement tasks.

**Measuring followers**
Universal measuring followers for different measuring tasks.

![](image1.png)  
**Flat measuring follower for crank shafts and convex cam shafts**

![](image2.png)  
**Round measuring follower made of different materials for cam shaft diameters**

**Workpiece drivers**
Universal standard workpiece drivers for the measurement of all common workpiece types. Application-specific drivers are also available.

![](image3.png)  
**Universal driver for cam shafts, gear shafts and crank shafts**

![](image4.png)  
**Workpiece-specific axial driver for cam shafts and crank shafts for angle indexing in axial bores**

![](image5.png)  
**Workpiece-specific radial driver for cam shafts for angle indexing in grooves**
Cam form deviation measurements at PTB* level

Thanks to the cam standards and the validated evaluation algorithms of the TURBO SHAFT software, traceable cam form deviation measurements can be performed for the first time.

- PTB certified evaluation software for cam shafts
- Calibrated cam standard
- Practice-oriented, reliable, traceable and therefore comparable status reports and status evaluations of cam shaft measurement systems
- Evaluation of form and dimensional deviations in all the main characteristics
- Comparability of evaluation strategies and detached consideration of the influence of the software from a purely mechanical measurement process
- Evidence of gaging machine capability (Cg, Cgk)
- For all CFM, shaftscan and CCM measuring machines

**Characteristics measured with the cam standard**

- Base circle radius
- Cam pitch
- Cam height
- Angle position
- Diameter
- Roundness
- Straightness
- Parallelism
- Coaxiality

**Certified evaluation software TURBO SHAFT**

- Validation of evaluation algorithms
- Definition of measuring uncertainty on the basis of synthetic reference information
- Certified measuring uncertainty of the software $\pm 0.1 \, \mu m$ or $\pm 0.1”$

---

*Physikalisch-Technische Bundesanstalt (PTB) – Federal Institute of Physical and Technical Affairs*
The Windows software TURBO SHAFT sets standards with its convenient operation and functionality:

- Fast and simple program creation thanks to standardized input assistance
- Extensive help functions
- Automatic creation of a CNC program with the input data
- Grouping functions support the clarity of complex CNC programs
- Entering of positions via teach-in
- „Copy & Paste“ for recurring characteristics, tolerances and nominal values

**Performance features**

- Definition of all measurement positions by entering a constant bearing and measurement track distance
- All measured values can be displayed for direct evaluation during the CNC run
- Automatic evaluation and determination of characteristics
- Documentation of measurement results using clear screen and print forms
- Export in ASCII format
- Saves and exports source data, result data and reports
- Offline programming
- NOK features are marked automatically
Evaluation of specific measurement tasks

Cam form profile over 360°
The cam form profile deviation can be detected in the area of the pre-cams, main cams or post-cams as well as on the base circle.

Chattermarks
Chattermarks are detected thanks to a frictionless measurement system with no reverse tension. As the measured values are recorded in the regular cam form measurement, there is no additional time outlay.

Axis parallelism of crank shaft pin bearings
Display of the direction and amount of the axis parallelism to a reference axis for each main bearing and pin bearing via vectors.

Wear evaluation for cam shafts
Determination of the material wear between two measurements. The form deviation difference is identified as the maximum wear with the amount and angle position.

Crowning evaluation
Either from the polar or the linear measurement.

Certified qs-STAT® interface
ASCII transfer format for local or central data storage.
Flexible measuring systems for form and roundness in cylinder bores

The incometer V measuring systems offer fast, reliable and highly accurate measurements for analytic examination of cylinder-piston configurations in engine block development.

**System features**
- Compact, robust measuring probe
- Scanning measuring method
- Simple operation via Windows software with pre-defined measuring routines
- By changing measuring tips and clamping jaws, the probe easily adjusts to different diameters

**Your benefits**
- Measurement of cylinder distortion and wear, also under temperature influences
- Assistance for the dimensioning of piston rings
- Measurement with mounted cylinder head possible

- **Measurement of cylinder distortion and wear, also under temperature influences**
- **Assistance for the dimensioning of piston rings**
- **Measurement with mounted cylinder head possible**
Measuring cylinder distortions
- Measurement and evaluation of the influence of cylinder heads and gaskets on bore distortion
- Thanks to its extremely compact design, the incometer probe can be installed on the crank shaft side in order to measure inside cylinder bores with the cylinder head mounted
- In the case of long-term testing, wear rates and cylinder distortion can also be monitored

Temperature distortion
- Simple fixturing and high speed allow for measurement of engine blocks, even under high temperature conditions
- Distortion-specific analysis of the critical warm-up phase with extreme differences in temperature between the cylinder head and the engine block

incometer VS for small engines
Analysis of cylinder distortions in small motors, e.g. for:
- Motorcycles
- Agricultural and forestry equipment
- Compressors of cooling systems

incometer V110 for flat engines
Analytical testing of the cylinder-piston configuration in engines with particularly difficult installation requirements, e.g. extremely flat V engines.

<table>
<thead>
<tr>
<th>Model</th>
<th>Test diameter</th>
<th>Axial measuring range</th>
<th>Radial measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>incometer V</td>
<td>65 – 155 mm</td>
<td>80 – 200 mm (depending on model)</td>
<td>±400 µm</td>
</tr>
<tr>
<td>incometer V110</td>
<td>65 – 155 mm</td>
<td>110 mm</td>
<td>±400 µm</td>
</tr>
<tr>
<td>incometer VS120</td>
<td>39 – 100 mm</td>
<td>120 mm</td>
<td>±500 µm</td>
</tr>
</tbody>
</table>
Fast form measurement in cylinder bores

The incometer P delivers fast, reliable and highly accurate quality data during production.

**System features**
- Compact and robust design for mobile use during production
- Minimization of disruptive vibrations thanks to direct mechanical connection between the measuring probe and the workpiece
- Automatic correction of inclinations and eccentricities by the software
- Precision measurements of roundness and form in seconds during engine production

**Your benefits**
- Fast measurement readiness, as no manual alignment is required
- Measurement of the cylinder bore in just a few seconds
- Fast adaptation to different bore diameters thanks to interchangeable measuring tips
- Ideally suited for flexible production lines
- Simple operation, even without previous experience
Easy handling and fast measurement

Measuring a cylinder bore with the incometer P takes only a few seconds:

• Insertion of the probe into the cylinder
• Plastic guide rails protect the cylinder wall
• Adjustment of the probe to the bore via a fixture plate
• Simply attaching the clamping levers connects the incometer P to the engine block

• Start of the measurement and 360° rotation of the measuring head
• Scanning, dynamic recording of the measurement values of all previously positioned sensors at a constant speed
• Measurement values are available immediately
• Choice of up to 7 sensors per measuring head

<table>
<thead>
<tr>
<th>Model</th>
<th>Test diameter</th>
<th>Axial measuring range</th>
<th>Radial measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>incometer P100</td>
<td>60 – 110 mm</td>
<td>max. 300 mm</td>
<td>±500/1000 µm (depending on the diameter)</td>
</tr>
</tbody>
</table>
The clearly structured INCOWIN software ensures that operating the measuring systems is easy, even with no previous experience. Once the measurements have been taken, all procedures, such as saving and printing the measurement results and statistically evaluating them, can be performed automatically. The advanced user administration (optional) allows hierarchical access to the individual functions of the INCOWIN software.

**Performance features**

- Optimal mobility with a notebook
- Clear and easy-to-understand user interface for intuitive operation
- Central data backup possible via network operation
- Rapid set-up of all user-specific requirements
- Multiple display options for easy analysis of the measurement results
- Easy creation of new measurement reports
- Customization of screen and print forms
- Language selection (English, German, French) during operation
- Simple project management
- Comfortable menu guidance
Dynamic measurement
INCOWIN offers extensive measuring functions and is equipped with a standardized high-resolution scanner. This ensures a very high resolution and a detailed display of the actual geometry of the cylinder bore. The high data density allows standardized filter methods to be used (e.g. Fourier and Gauss filters or median filter for eliminating individual outliers).

Optimum mobility
The incometer systems are operated with a notebook for mobile use. The overall logic is generated on an interface card, which is installed in the electronics unit. The connection to the computer consists of a serial interface cable.

Unrestricted upgrade capability
Measurement systems can be retrofitted at any time. The cost will vary depending on the age and technological status of the system, and must be determined on a case-by-case basis.

Customizable range of functions
INCOWIN can be extended by software options and the range of functions can be customized, thereby ensuring maximum clarity.

Optional offline software
This module enables external (offline) evaluation and analysis of the measurement data from the incometer form measuring system on a separate computer.
Wear measurement
In order to measure the liner wear in previously used cylinder bores, the cylinder bore is measured in high resolution with axial scans equally distributed around the circumference.

Measuring temperature distortion
Due to the very fast complete cylinder measurement, the incometer systems are also able to measure hot engines (up to over 120°C), allowing temperature distortion to be identified on a „living“ object.

Fourier analysis
Distortions are calculated using the Fourier analysis method for a more precise description of the cylinder form.

„Copy & Paste“/Data export
Both the graphics and the parameter list can be exported to another format or to other Windows applications.

Differentiation
For analyzing distortion changes with different configurations of the cylinder head, the cylinder head seal and the crankcase, or for hot distortion evaluations. A difference is generated based on measurements that have been carried out at different times in order to draw a direct comparison between them.

Data import
External data (polar, Cartesian or as Fourier coefficients) can be imported into the INCOWIN software, evaluated with the same algorithms as „normal“ measurements, and compared with the incometer measurements.
Software options for the production

Block measurement and complete evaluation
For measuring a complete crankcase with one-time input of the reference data. The user is guided through the entire measuring procedure via diagrams. All cylinder measurements of a crankcase are saved in a single file. The evaluation contains the printout of the form parameters for all cylinders in a table and provides a graphic display of the radial and axial measurement and the isometries for all cylinders on one page.

Data transfer to qs-STAT®
The qs-STAT® interface certified by Q-DAS allows the measurement results to be transferred to a statistics package for further process data analysis.

Determining the absolute diameter
For determining the absolute diameter of the cylinder of a crankcase. To this end, the incometer is calibrated to the nominal dimension of the cylinder diameter before each measurement.

Advanced user administration
For creating different users and user groups with their own profiles. The individual users can each be assigned to a specific group and given a personal password.

Automatic functions
For automating processes, such as saving, printing etc., in order to reduce errors resulting from incorrect inputs or user mistakes.
## Technical data

### HOMMEL-ETAMIC F series and roundscan

<table>
<thead>
<tr>
<th>Model</th>
<th>F50</th>
<th>F135/F155</th>
<th>F435/F455</th>
<th>roundscan 53S</th>
<th>roundscan 55S</th>
<th>roundscan 590</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td></td>
<td></td>
<td></td>
<td>740 (840)* mm</td>
<td>740 (840)* mm</td>
<td>740 (840)* mm</td>
</tr>
<tr>
<td>Max. workpiece diameter</td>
<td>220 mm</td>
<td>300 mm</td>
<td>400 mm</td>
<td>390 (490)* mm</td>
<td>390 (490)* mm</td>
<td>390 (490)* mm</td>
</tr>
<tr>
<td>Max. measuring height</td>
<td>320 (560) mm</td>
<td>350/550 mm</td>
<td>350/550 mm</td>
<td>350 mm</td>
<td>550 mm</td>
<td>900 mm</td>
</tr>
<tr>
<td>Rotation axis (C axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table diameter</td>
<td>150 mm</td>
<td>150 mm</td>
<td>250 mm</td>
<td>330 mm</td>
<td>330 mm</td>
<td>330 mm</td>
</tr>
<tr>
<td>Workpiece alignment</td>
<td>manual</td>
<td>manual</td>
<td>automatic</td>
<td>automatic</td>
<td>automatic</td>
<td>automatic</td>
</tr>
<tr>
<td>Roundness error µm+µm/mm measuring height</td>
<td>0.05±0.0005 µm</td>
<td>0.05±0.0005 µm</td>
<td>0.02±0.0005 µm</td>
<td>0.02±0.0005 µm</td>
<td>0.02±0.0005 µm</td>
<td>0.02±0.0005 µm</td>
</tr>
<tr>
<td>Axial run-out error µm+µm/mm radius</td>
<td>0.025±0.00025 µm</td>
<td>0.025±0.00025 µm</td>
<td>0.015±0.00025 µm</td>
<td>0.015±0.00025 µm</td>
<td>0.015±0.00025 µm</td>
<td>0.015±0.00025 µm</td>
</tr>
<tr>
<td>Centering range</td>
<td>±0.6°</td>
<td>±0.6°</td>
<td>±0.6°</td>
<td>±1°</td>
<td>±1°</td>
<td>±1°</td>
</tr>
<tr>
<td>Leveling range</td>
<td>1–10 1/min.</td>
<td>1–10 1/min.</td>
<td>1–12 1/min.</td>
<td>0.2–30 1/min.</td>
<td>0.2–30 1/min.</td>
<td>0.2–30 1/min.</td>
</tr>
<tr>
<td>Measuring and positioning speed</td>
<td>250 N</td>
<td>250 N</td>
<td>400 N</td>
<td>600 (1000)* N</td>
<td>600 (1000)* N</td>
<td>600 (1000)* N</td>
</tr>
<tr>
<td>Vertical axis (Z axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traverse distance</td>
<td>320 mm</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>–</td>
<td>350/550 mm</td>
<td>350/550 mm</td>
<td>350 mm</td>
<td>550 mm</td>
<td>900 mm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>0.15 µm</td>
<td>0.15 µm</td>
<td>0.15 µm</td>
<td>0.15 µm</td>
<td>0.15 µm</td>
<td>0.15 µm</td>
</tr>
<tr>
<td>Straightness error/measuring distance</td>
<td>–</td>
<td>0.3/0.4 µm</td>
<td>0.3/0.4 µm</td>
<td>0.3 µm</td>
<td>0.3 µm</td>
<td>0.3 µm</td>
</tr>
<tr>
<td>Parallel C-Z/measuring distance</td>
<td>–</td>
<td>0.8/1.3 µm</td>
<td>0.8/1.3 µm</td>
<td>0.5 µm</td>
<td>0.8 µm</td>
<td>2.5 µm</td>
</tr>
<tr>
<td>Measuring and positioning speed</td>
<td>–</td>
<td>0.2–23 mm/s</td>
<td>0.2–23 mm/s</td>
<td>0.2–50 mm/s</td>
<td>0.2–50 mm/s</td>
<td>0.2–50 mm/s</td>
</tr>
<tr>
<td>Collision protection</td>
<td>–</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Horizontal axis (R axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traverse distance</td>
<td>160 mm</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>–</td>
<td>220 mm</td>
<td>220 mm</td>
<td>220 mm</td>
<td>220 mm</td>
<td>220 mm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>0.3 µm</td>
<td>0.3 µm</td>
<td>0.3 µm</td>
<td>0.25 µm</td>
<td>0.25 µm</td>
<td>0.25 µm</td>
</tr>
<tr>
<td>Straightness error/measuring distance</td>
<td>–</td>
<td>0.6 µm</td>
<td>0.6 µm</td>
<td>0.5 µm</td>
<td>0.5 µm</td>
<td>0.5 µm</td>
</tr>
<tr>
<td>Squareness C-R</td>
<td>–</td>
<td>1.2 µm</td>
<td>1.2 µm</td>
<td>0.8 µm</td>
<td>0.8 µm</td>
<td>0.8 µm</td>
</tr>
<tr>
<td>Measuring and positioning speed</td>
<td>–</td>
<td>0.2–14 mm/s</td>
<td>0.2–14 mm/s</td>
<td>0.2–50 mm/s</td>
<td>0.2–50 mm/s</td>
<td>0.2–50 mm/s</td>
</tr>
<tr>
<td>Dimensions/weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>475 (635) mm</td>
<td>700 (810)** mm</td>
<td>790 (1010)** mm</td>
<td>1990 mm</td>
<td>1990 mm</td>
<td>1990 mm</td>
</tr>
<tr>
<td>Width</td>
<td>285 mm</td>
<td>410 (550)** mm</td>
<td>510 (650)** mm</td>
<td>750 mm</td>
<td>750 mm</td>
<td>750 mm</td>
</tr>
<tr>
<td>Height</td>
<td>710 mm</td>
<td>950/1150 mm</td>
<td>960/1160 mm</td>
<td>1760 mm</td>
<td>1960 mm</td>
<td>2310 mm</td>
</tr>
<tr>
<td>Weight (approx.)</td>
<td>60 kg</td>
<td>185/200 kg</td>
<td>290/300 kg</td>
<td>650 kg</td>
<td>665 kg</td>
<td>685 kg</td>
</tr>
</tbody>
</table>

All accuracy data according to EN ISO 1101 at 20°C ±1°C in vibration neutral environment. Filter 0–15 rpm LSCI, or 2.5 mm LSLI; 6 rpm, or 4 mm/s.
All proof on standard under inclusion of the compensation method.

* On request
** Values as maximum deviation from the reference circle LSCI, filter 0–15 rpm LSCI, 6 rpm
*** R axis extended
**** With servo box
### Technical data

#### HOMMEL-ETAMIC FMS

<table>
<thead>
<tr>
<th>Model</th>
<th>FMS200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>300 mm</td>
</tr>
<tr>
<td>Max. test diameter</td>
<td>1250 (1500)* mm</td>
</tr>
<tr>
<td>Max. measuring height</td>
<td>210 mm</td>
</tr>
<tr>
<td>Rotation axis (C axis)</td>
<td>600 x 450 mm</td>
</tr>
<tr>
<td>Workpiece alignment</td>
<td>automatic</td>
</tr>
<tr>
<td>Roundness error radial/µm±µm/mm</td>
<td>0.1+0.0008 µm</td>
</tr>
<tr>
<td>Measuring height</td>
<td>0.1+0.0008 µm</td>
</tr>
<tr>
<td>Axial run-out error/µm±µm/mm</td>
<td>0.01°</td>
</tr>
<tr>
<td>Bearing</td>
<td>air</td>
</tr>
<tr>
<td>Max. charge</td>
<td>3000 N</td>
</tr>
<tr>
<td>Traversing speed</td>
<td>max. 12 rpm</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1°</td>
</tr>
<tr>
<td>Vertical axis (Z axis)</td>
<td>1300 mm</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>0.3 µm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>2.6 µm</td>
</tr>
<tr>
<td>Measuring speed</td>
<td>16 mm/s</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>25 mm/s</td>
</tr>
<tr>
<td>Positioning error/µm</td>
<td>15.0±1300 mm</td>
</tr>
<tr>
<td>Horizontal axis (R axis)</td>
<td>150 mm + 100 mm rel.</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>800 mm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>0.3 µm</td>
</tr>
<tr>
<td>Measuring speed</td>
<td>1.6980 mm</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>25 mm/s</td>
</tr>
<tr>
<td>Positioning error/µm</td>
<td>10.0±800 mm</td>
</tr>
<tr>
<td>Straightness axis (X axis)</td>
<td>measuring</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>800 mm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>0.3 µm</td>
</tr>
<tr>
<td>Measuring speed</td>
<td>16 mm/s</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>25 mm/s</td>
</tr>
<tr>
<td>Positioning error/µm</td>
<td>6.0±500 mm</td>
</tr>
<tr>
<td>Dimensions/weight</td>
<td>Length 1704 mm</td>
</tr>
<tr>
<td>Width 2250 mm</td>
<td></td>
</tr>
<tr>
<td>Height 3316 mm</td>
<td></td>
</tr>
<tr>
<td>Weight (approx.) 750 kg</td>
<td></td>
</tr>
</tbody>
</table>

#### HOMMEL-ETAMIC CFM, shaftscan and CCM

<table>
<thead>
<tr>
<th>Model</th>
<th>CFM3010</th>
<th>shaftscan 1030</th>
<th>CCM2010/CCM2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>205 mm</td>
<td>205 mm</td>
<td>175 mm</td>
</tr>
<tr>
<td>Max. test diameter</td>
<td>300 mm</td>
<td>300 mm</td>
<td>118 mm</td>
</tr>
<tr>
<td>Max. measuring height</td>
<td>1250 (1500)* mm</td>
<td>1000 mm</td>
<td>1100/1000 mm</td>
</tr>
<tr>
<td>Max. traverse distance radial</td>
<td>210 mm</td>
<td>210 mm</td>
<td>60 mm</td>
</tr>
<tr>
<td>Rotation axis (C axis)</td>
<td>196 mm</td>
<td>196 mm</td>
<td>157 mm</td>
</tr>
<tr>
<td>Workpiece alignment</td>
<td>tips</td>
<td>tips</td>
<td>tips</td>
</tr>
<tr>
<td>Measuring speed</td>
<td>2–40 1/min.</td>
<td>2–40 1/min.</td>
<td>2–40 1/min.</td>
</tr>
<tr>
<td>Bearing</td>
<td>mechanical</td>
<td>mechanical</td>
<td>mechanical</td>
</tr>
<tr>
<td>Max. charge</td>
<td>1500 N</td>
<td>1500 N</td>
<td>500 N</td>
</tr>
<tr>
<td>Traversing speed</td>
<td>2–40 1/min.</td>
<td>2–40 1/min.</td>
<td>2–40 1/min.</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.00005°</td>
<td>0.00005°</td>
<td>0.001°</td>
</tr>
<tr>
<td>Positioning accuracy</td>
<td>0.1°</td>
<td>0.1°</td>
<td>0.1°</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.00028°</td>
<td>±0.00028° &lt; 0.5 µm</td>
<td></td>
</tr>
<tr>
<td>Run-out accuracy of the roller bearing</td>
<td>0.25 µm</td>
<td>0.25 µm</td>
<td>0.1 mm</td>
</tr>
<tr>
<td>Vertical axis (Z axis)</td>
<td>1290 (1590)* mm</td>
<td>1250 mm</td>
<td>200 mm</td>
</tr>
<tr>
<td>Measuring distance</td>
<td>0.05 mm</td>
<td>0.05 mm</td>
<td>0.1 mm</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>5–150 mm/s</td>
<td>5–150 mm/s</td>
<td>200 mm/s</td>
</tr>
<tr>
<td>Positioning error/measuring distance</td>
<td>0.05 mm</td>
<td>0.05 mm</td>
<td>0.1 mm</td>
</tr>
<tr>
<td>Resolution of the Z scale</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>±3 µm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±3 µm</td>
<td>±3 µm</td>
<td>±3 µm</td>
</tr>
<tr>
<td>Straightness error/100 mm</td>
<td>0.3 µm</td>
<td>0.3 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Measuring point distance</td>
<td>210 mm</td>
<td>210 mm</td>
<td>60 mm</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.02 µm</td>
<td>0.02 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.2 µm</td>
<td>±0.2 µm</td>
<td>±0.5 µm</td>
</tr>
<tr>
<td>Setting range of measurement force</td>
<td>1, 2, 3 and 4 N</td>
<td>1, 2, 3 and 4 N</td>
<td>1, 2, 3 and 4 N</td>
</tr>
<tr>
<td>Travel in X direction</td>
<td>0.1/0.2/0.5/1</td>
<td>0.1/0.2/0.5/1</td>
<td>0.1/0.2/0.5/1</td>
</tr>
<tr>
<td>Resolution radial</td>
<td>0.02 µm</td>
<td>0.02 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Resolution axial</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Dimensions/weight</td>
<td>Length 1240 mm</td>
<td>1650 mm</td>
<td>2000 mm</td>
</tr>
<tr>
<td>Width 1360 mm</td>
<td>1130 mm</td>
<td>1000 mm</td>
<td></td>
</tr>
<tr>
<td>Height 2450 mm</td>
<td>2300 mm</td>
<td>1150 mm</td>
<td></td>
</tr>
<tr>
<td>Weight (approx.) 2400 kg</td>
<td>2100 kg</td>
<td>1500 kg</td>
<td></td>
</tr>
</tbody>
</table>

* On request

CCM2020: 935 per measuring slide
**Technical data**

### HOMMEL-ETAMIC incometer

<table>
<thead>
<tr>
<th></th>
<th>incometer V</th>
<th>incometer VS</th>
<th>incometer P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of the cylinder*</td>
<td>65 – 155 mm</td>
<td>39 – 100 mm</td>
<td>60 – 110 mm</td>
</tr>
<tr>
<td>Clamping length min.</td>
<td>20 mm</td>
<td>20 mm</td>
<td>25 mm, 30 mm, 40 mm, ext. fixture</td>
</tr>
<tr>
<td>Axial measuring range</td>
<td>80 mm, 115 mm</td>
<td>150 mm, 200 mm, 110 mm</td>
<td>120 mm, max. 300 mm</td>
</tr>
<tr>
<td>Measuring path on the circumference</td>
<td>360°</td>
<td>360°</td>
<td>360°</td>
</tr>
<tr>
<td>Radial measuring range</td>
<td>± 400 µm</td>
<td>± 500 µm</td>
<td>± 500/1000 µm***</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Number of measured values per rotation</td>
<td>14,400/1,024</td>
<td>14,400/1,024</td>
<td>14,400/1,024</td>
</tr>
<tr>
<td>Number of sensors</td>
<td>1</td>
<td>1</td>
<td>max. 7</td>
</tr>
<tr>
<td>Repeating accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roundness</td>
<td>≤ 1.0 µm</td>
<td>≤ 1.0 µm</td>
<td>≤ 1.0 µm</td>
</tr>
<tr>
<td>Cylinder form</td>
<td>≤ 1.5 µm</td>
<td>≤ 1.5 µm</td>
<td>≤ 1.0 µm</td>
</tr>
<tr>
<td>Parallelism</td>
<td>≤ 1.5 µm</td>
<td>≤ 1.5 µm</td>
<td>-</td>
</tr>
<tr>
<td>Measuring accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roundness</td>
<td>≤ 1.0 µm</td>
<td></td>
<td>≤ 1.0 µm</td>
</tr>
<tr>
<td>Cylinder form</td>
<td>≤ 1.5 µm</td>
<td></td>
<td>≤ 2.0 µm</td>
</tr>
<tr>
<td>Parallelism</td>
<td>≤ 1.5 µm</td>
<td></td>
<td>≤ 2.0 µm</td>
</tr>
<tr>
<td>Temperature range of use**</td>
<td>20 – 40 °C</td>
<td>20 – 40 °C</td>
<td>20 – 40 °C</td>
</tr>
<tr>
<td>Power supply</td>
<td>230 V / 50 Hz, 115 V / 60 Hz</td>
<td>230 V / 50 Hz, 115 V / 60 Hz</td>
<td>230 V / 50 Hz, 115 V / 60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>150 W</td>
<td>150 W</td>
<td>150 W</td>
</tr>
<tr>
<td>Weight of the sensor</td>
<td>2.9 kg</td>
<td>1.9 kg</td>
<td>8 kg***</td>
</tr>
</tbody>
</table>

* Further diameters on demand
** Measuring of the warm distortion on demand (up to 130°C)
*** Dependent on diameter

### Product range for incometer

<table>
<thead>
<tr>
<th></th>
<th>Ø min/max</th>
<th>Height / Depth</th>
<th>Width of part</th>
<th>Laboratory</th>
<th>Offline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>39 – 155 mm</td>
<td>≤ 200 mm</td>
<td>≤ 200 mm</td>
<td>incometer VS</td>
<td>incometer P</td>
</tr>
<tr>
<td>Cylinder liners</td>
<td>39 – 155 mm</td>
<td>≤ 200 mm</td>
<td>≤ 200 mm</td>
<td>incometer VS</td>
<td>incometer P</td>
</tr>
</tbody>
</table>
Excellent industrial metrology

**WAVELINE**
Roughness and Contour Metrology
Mobile roughness measuring devices and manual or automated surface measuring systems for measuring roughness, contour, topography and twist, combined systems for roughness and contour, visual surface inspection for cylinder bores as well as customized solutions.

**FORMLINE**
Form Metrology
Manual and CNC-controlled systems for measuring form, position and twist (device-dependent); combined form and roughness measuring systems, systems for form measurement in cylinder bores, spindle measuring machines, crank shaft and cam shaft measuring machines and workpiece-specific solutions.

**OPTICLINE**
Optical Shaft Metrology
Optical measuring systems for determining dimensions, form, position and geometric elements on shaft-shaped workpieces. Use as a SPC measuring station, offline or automated stations in concatenated applications and as customized solutions for workpiece-specific requirements.

**GAGELINE**
Dimensional Metrology
Pre-process/in-process/post-process measuring systems with tactile, pneumatic or optical measuring principles, manual and automatic measuring devices, final inspection measuring machines, customized inline measuring systems and optical surface inspection.

**MOVOLINE**
In-Process Metrology
Digital measuring heads, control devices and accessories for tactile in-process measurement of diameter, position and length in tooling machines with an aim to controlling the machining process.

**SERVICELINE**
Services Worldwide
Services relating to metrology such as consultation and training, order measurements and relocation services, production monitoring, (remote) maintenance and calibration, repairs and spare parts/replacement service, measuring program development and measurement process optimization.